11 ENVIRONMENT, SAFETY AND HEALTH

11.1 Scope and Content

The scope and intent of this Environment, Safety and Health analysis is to:

1. Identify codes and standards applicable to conventional facility design.
2. Identify specific criteria for design of the conventional facility building and systems that meet the requirements of the applicable codes and standards, particularly those criteria that address the hazards identified by BNL in the Preliminary Hazards Analysis.
3. Define concepts for the conventional facility building and safety systems design to mitigate the identified hazards.

This ES&H analysis includes the following sections:

1. Building Code Analysis (BCNY)
2. Other Codes and Standards
3. Preliminary Hazards Analysis
4. Fire Protection
5. Pressure Safety
6. Industrial Hygiene
7. Other ES&H Issues

This document will be used as a reference by the design team and BNL throughout subsequent phases of the project.

11.2 Building Code Analysis

The preliminary building code analysis is attached to the end of this report.

11.3 Other Codes and Standards

The following DOE Orders and Guidelines will govern design and operation of the facility. Specific requirements in each order or guideline that are applicable to the facility design are summarized.

Where specific requirements conflict, or conflict with the Building Code of New York State, the more stringent requirement will govern.

11.3.1 DOE O 420.1B – Facility Safety

a) Fire protection system design

b) Natural phenomena hazards mitigation

11.3.2 DOE O 420.2B -Safety of Accelerator Facilities

a) Beamline safety systems (access control, beamline shutoffs/ interlocks, search confirmation system)

b) Electrical safety

c) Cryogenic and oxygen-deficiency hazards

d) Ionizing and non-ionizing radiation

e) Experimental activities

11.3.3 10 CFR 851 – Worker Safety and Health Program

a) Fire protection

b) Pressure safety

c) Industrial hygiene

d) Biological safety

e) Electrical safety

f) Nanotechnology safety

11.3.4 BNL Worker Safety and Health Program

a) To be confirmed during detailed design

11.4 Preliminary Hazards Analysis

BNL has developed a Preliminary Hazards Analysis (PHA) which identifies hazards related to facility construction and operation. This analysis will be updated to a Final Hazards Analysis for submission at Critical Decision 2 (CD-2).

The Hazards Analysis is used to identify design and operation strategies to mitigate potential hazards. Relevant findings and requirements from the Preliminary Hazards Analysis are incorporated into the following sections.

A summary of the risk assessment from the Preliminary Hazards Analysis, with pre-and post-mitigation risk categories, is presented in Table 11.1 for reference. A full description of the design and operation mitigation strategies is provided in the PHA.

Table 11.1 Preliminary Hazards Analysis

PHA Hazard Identifier	Hazard	Pre-Mitigation Risk Category	Post Mitigation Risk Category
NSLS-II PHA - 1	Construction	High	Moderate
NSLS-II PHA – 2	Natural Phenomena	Low	Routine
NSLS-II PHA – 3	Environmental	Moderate	Low
NSLS-II PHA – 4	Waste	Moderate	Low
NSLS-II PHA – 5	Fire	High	Low
NSLS-II PHA – 6	Electrical	High	Moderate
NSLS-II PHA – 7	Noise	Moderate	Low
NSLS-II PHA – 8	Cryogenic	Moderate	Low
NSLS-II PHA – 9	Confined space	Moderate	Low
NSLS-II PHA – 10	Ozone	Low	Low
NSLS-II PHA – 11	Chemical/hazmat	High	Moderate
NSLS-II PHA – 12	Vacuum, cooling water, air	Moderate	Low
NSLS-II PHA – 13	Ionizing Radiation	High	Moderate
NSLS-II PHA – 14	Non-Ionizing Radiation	Moderate	Low
NSLS-II PHA – 15	Material Handling	High	Moderate
NSLS-II PHA – 16	Experimental Operations	High	Moderate

This section of the Title I design narrative addresses, directly or indirectly, all of the hazards identified in the Preliminary Hazards Analysis except construction hazards and natural phenomena hazards. The latter are addressed in the civil, structural, and architectural chapters of this narrative. Construction hazards will be addressed separately.

11.5 Fire Protection

11.5.1 Requirements

For the purposes of this analysis, “Fire Protection” includes the following elements as defined in DOE Order 420.1B – Facility Safety:

a) Water supply

b) Fire-rated construction and barriers

c) Automatic extinguishing systems

d) Redundant fire protection systems for vulnerable safety class systems

e) Emergency egress and illumination

f) Fire department access and standpipe systems

g) Containment of fire fighting water

Requirements and criteria for fire protection are derived from the following codes and orders:

a) Building Code of New York State (2002)

b) Fire Code of New York State (2002)

c) DOE O 420.1B – Facility Safety

d) DOE O 420.2B – Safety of Accelerator Facilities

e) 10 CFR 851 – Worker Safety and Health Program

Design mitigation strategies are also identified in the PHA under PHA-5.

11.5.2 Codes and Standards

The following codes and standards will apply to design of fire protection systems.

a) DOE STD-1066-99 – Fire Protection System Design Criteria

b) NFPA 70 – National Electrical Code (2005)

c) NFPA 70E – Standard for Electrical Safety in the Workplace (2004)

d) NFPA 101 – Life Safety Code (2006)

e) NFPA 90A – Standard for Installation of Air-Conditioning and Ventilating Systems (2002)

f) NFPA 780 – Standard for Installation of Lightning Protection Systems (2004)

g) NFPA 72 – National Fire Alarm Code (2007)

h) NFPA 14 – Standard for the Installation of Standpipe and Hose Systems (2003)

i) NFPA 45 – Standard on Fire Protection for Laboratories Using Chemicals (2004)

j) NFPA 13 – Standard for the Installation of Sprinkler Systems (2002)

11.5.3 Compartmentation

The BCNY requires fire rated barriers at the following locations, as indicated in Section B - Building Code Analysis:

a) Occupancy separations

b) Control area separations

c) Vertical exit enclosures

d) Horizontal exit enclosures

DOE Order 420.1B also requires construction of fire rated barriers to limit maximum possible fire loss (MPFL) from a single fire event to $50 million, or installation of redundant fire protection systems where the MPFL exceeds this limit.

The MPFL is defined as the value of property (excluding land), within a fire area, including the replacement cost of equipment and property and any applicable decontamination and clean-up costs following a fire event. This loss assumes the failure of both automatic fire sprinkler systems and manual fire fighting efforts. A waiver from the DOE will be required to allow the experimental hall and tunnel to be constructed without intermediate fire barriers since the MPFL value of these spaces exceeds the established limit.

For the NSLS-II facility, fire rated barriers are proposed at the following locations:

a) 1-hour fire rated separation between the experimental hall and each LOB

b) 1-hour fire rated enclosure around stairwells in the service buildings and the operations center

c) 2-hour fire rated separation between the operation center (portion inside the ring) and the ring building

d) no fire barrier separation within the experimental hall or the tunnel

e) no fire barrier separation between the experimental hall and the service buildings, RF service building, or booster ring building

11.5.4 Fire Department Access

The Fire Code of New York State requires a Fire Department access to be a minimum of 14 feet high and 20 feet wide. This will accommodate the BNL Fire Department's largest response vehicle (22 tons, 37 feet long, 13 feet high, and 11 feet wide). The Fire Department will be able to reach NSLS-II by road from the north, west or south.

Access to the NSLS-II building complex will be provided from Brookhaven Avenue to the main facility entrance, to the west end of the facility perimeter road (bypassing the main parking areas), and directly to the perimeter road east entrance. Additional points of access to the west side of the perimeter road will be from Bell Avenue and Rowland Street, and to the south from Princeton Street via Weaver Drive or Groves Street. Each LOB is accessed from the perimeter road. The main entrance is accessed directly off of Brookhaven. Access to the service buildings, RF Building, and Injection Buildings will be from the inside of the main ring building via a tunnel from the perimeter road. The tunnel will be sized to accommodate the largest BNL firefighting vehicle and will have a maximum 8 percent slope.

There is the potential for construction of long beamlines in the southeast quadrant of the building that could cross the perimeter road. Any changes in perimeter road grade will be limited to a maximum 8 percent slope.

There will be 10 primary entrances for emergency responders to the NSLS-II building, six from outside and 5 from inside the ring building. These primary entrances are:

a) Main entrance to the Operations Building

b) Main truck dock entrance to each LOB

c) Service building (access from inside the ring)

d) Exterior door where Alternate LOB will be located.

Because of the size of the facility, a means of easily identifying emergency responder access points during daytime and nighttime hours will be provided. This will be further developed during detailed design.

11.5.5 Fire Protection Water Supply

DOE Standard 1066-99 specifies requirements for fire protection water supply, including hydrant demand. This standard also requires that an additional, independent source of fire protection water be provided when the Maximum Possible Fire Loss (MPFL) is in excess of $100 million.

For the NSLS-II facility, fire protection water will be supplied by BNL's potable water system, which is supplied by several deep wells and is stabilized by two elevated water storage tanks (one with a capacity of 1 million gallons and another of 350,000 gallons). The system can sustain three days of domestic supply and a maximum fire demand (4000 gpm for 4 hours) for BNL when two of the system's largest pumps are out of service and one storage tank is unavailable. The piping distribution network is well gridded to reduce the impact to any one building from a single water main break.

Five (5) potable water/fire water services will be extended from the site water mains to the service buildings. Each feed into the building will be hydraulically sized to handle the total combined requirements for water supply of the domestic and automatic sprinkler/standpipe systems.

Each service will be provided with two reduced pressure backflow prevention devices. The potable water supply will be protected against backflow from the automatic fire sprinkler and standpipe systems by an Underwriters Laboratory and Factory Mutual listed reduced pressure principle backflow preventor as required by Section 608.16.4.of the Plumbing Code of New York State (PCNY).

11.5.6 Fire Protection

BCNY Section 903 defines fire protection requirements applicable to the NSLS-II facility.

DOE Standard 1066-99 specifies that sprinkler systems must be designed in accordance with NFPA Standard 13.

DOE Standard 1066-99 also specifies the following fire protection system requirements to limit loss potential. Implementation or waiver of both of these requirements will need further review with the DOE.

a) A redundant fire protection system that, despite the failure of the primary fire protection system, will limit the loss to acceptable levels as determined by the AHJ (when the MPFL exceeds $50 million)

b) A redundant fire protection system and a 3-hour fire barrier when the MPFL exceeds $150 million

Neither the FCNY nor DOE Standard 1066-99 require standpipes for buildings less than 3 stories in height, unless deemed necessary for facilities with “extensive and complex interior layouts” by the DOE Fire Protection AHJ. Where standpipes are installed they shall be designed to NFPA Standard 14.

DOE Standard 1066-99 indicates that hydrants should be provided so that hose runs to all exterior portions of a protected building are no more than 300 feet, and that hydrants are located not closer than 40 feet to buildings. Hydrant water supply should be per the FCNY for the most severe facility fire risk, reduced as allowed for building automatic sprinkler protection.

For the NSLS-II facility, a combination sprinkler/standpipe system meeting the requirements of NFPA 13 “Standard for Installation of Sprinklers” and NFPA 14 “Standard for the Installation of Standpipe and Hosepipe Systems” will be designed to provide 100-percent protection of the facility. Where the piping installation will be subject to freezing temperatures, dry sprinklers will be employed; this will be further evaluated during detailed design. Means of adding water conditioning chemicals to the sprinkler system to combat corrosion will be provided.

Two Fire Department connections for each of the five fire (5) zones. One connection shall be located on the front face of the building, and the other on the interior face (courtyard) of the building. Each shall be located near an entry point into the facility. Each pair of FDC will serve a single fire zone and will be interconnected with the automatic sprinkler and standpipe systems.

Fire hydrants will be located along the Loop Road outside of the Ring Building and along the Service Road inboard of the Ring Building at distances meeting DOE and code requirements and not more than 300 feet from all building entrances.

11.5.7 Detection and Alarming

Specific requirements for fire detection and notification in the BCNY/FCNY will be detailed in the next phase of design.

DOE Standard 1066-99 requires that fire alarm systems comply with NFPA 72 - National Fire Alarm Code and have the following features:

a) Retransmission of signals to the site Fire Department alarm center

b) Local alarms for the building or zone(s) in alarm.

c) Visual alarms.

d) Location of a fire alarm control panel near the main entrance or other protected location as determined by the AHJ. For buildings with multiple zones, a zone alarm panel or graphic is required at the main entrance.

e) Supervisory devices except for locked valves.

f) Water flow alarm at each sprinkler riser.

g) Means of manual fire notification.

For NSLS-II, a complete manual and automatic, supervised, fire detection and voice evacuation system meeting the requirements of NFPA 72 will be provided. It will be a non-coded, addressable, microprocessor-based fire alarm system with initiating devices, notification appliances, and monitoring and control devices. Initiating and appliance circuits will be Class B. The fire alarm system will be in accordance with DOE and NY State Code requirements.

Smoke detection will be provided in laboratories in the LOBs, in the control room, in all electrical rooms (including switchgear rooms in the Service Buildings), in telephone and data communications rooms, and in elevator lobbies, shafts and machine rooms. Provisions will be provided for connecting future smoke detectors located within the future experimental hutches. Smoke detectors in elevator lobbies, shafts and machine rooms will initiate elevator recall. Duct smoke detectors will be provided in air handling systems as required by BCNY and NFPA 90A. Manual pull stations will be located at each building exit.

High sensitivity smoke detectors (HSSD systems) will be provided in four (4) areas: the Experiment Floor, the Tunnel Mezzanine area, the accelerator ring tunnel and the booster tunnel.

Heat detectors will de-energize elevator power in accordance with ANSI 17.1 Elevator Code.

Sprinkler system water flow will be monitored and the system will supervise the sprinkler valves and the installed detection systems.

Combination audible/visual alarm and/or visual only annunciation devices to alert the occupants will be provided throughout the ring, the corridor system, in each laboratory, in each hutch, and in most rooms, other than single person offices. Fire alarm and supervisory signals will be transmitted via dedicated fiber optic cable to the BNL Fire Rescue Group in Building 599 monitors and to a secondary monitoring station at Security (Bldg 50) via the Site Fire Alarm System. All fire alarm signals will also annunciate in the control room. The main fire alarm control panel will be located at the facility entrance, with repeater panels located at the entrance to each LOB and each Service Building.

Spot smoke detection will be arranged to have a “pre-alarm” signal (permissible by NFPA 72 with the approval of the Authority Having Jurisdiction). This “pre-alarm” signal from single smoke detector(s) will be displayed in the control room and transmitted to the BNL Fire Rescue Group without immediately activating the fire alarm audible/visual devices. Notification devices will be activated automatically within a fixed time period unless the facility operators in the main control room do not put the system on hold.

11.5.8 Smoke Control

No code requirements have been identified that would require installation of a means of smoke control for the tunnel, experimental hall, or lab office buildings. However, BNL has indicated a need for smoke control from the experimental hall, the accelerator ring tunnel, and the booster tunnel to further enhance the ability to quickly evacuate personnel from this space in a fire emergency and to limit the spread of fire/smoke beyond the point of origin. The Fire Department will have the ability to control the ventilation systems to divert recirculated air to the outdoors. Fresh air would not continue to be supplied from the activated GHVAC system. The control panel will be at the fire alarm system panels.

11.6 Pressure Safety

11.6.1 Requirements

Requirements and criteria for pressure safety are derived from the following:

a) 10 CFR 851 – Worker Safety and Health Program

11.6.2 Applicable Codes and Standards

The following codes and standards will apply to the design and fabrication of pressure systems.

a) ASME Boiler and Pressure Vessel Code (2007)

b) ANSI B31.3 – Process Piping (2002)

c) ANSI B31.9 – Building Services Piping (1996)

d) CGA S-1.3 – Pressure Relief Device Standards Part 3 – Stationary Storage Containers for Compressed Gases (2005)

11.6.3 Design Requirements

Specific requirements for implementation of pressure safety-related codes and standards will be defined in the next phase of design. These requirements may include, but not be limited to, the following.

a) Incorporation of applicable codes and standards into the relevant construction specifications.

b) Location of compressed gas cylinder racks in areas protected from potential damage or potential sources of energy that could cause an overpressure condition.

c) Specification and selection of appropriate relief valves and other protective devices on mechanical and process services under pressure.

d) Routing of relief valve and rupture disk discharges to safe locations, away from potential personnel travel pathways.

e) Routing of pressurized services away from exposure to damage from mobile equipment, hoists, etc.

11.7 Industrial Hygiene

11.7.1 Requirements

Requirements and criteria for industrial hygiene are derived from the following codes and orders:

a) Building Code of New York State (2002)

b) DOE O 420.2B –Safety of Accelerator Facilities

c) 10 CFR 851 – Worker Safety and Health Program

Design mitigation strategies are also identified in the PHA under the following:

a) Waste Hazards (PHA-4)

b) Noise and Vibration Hazards (PHA-7)

c) Cryogenic Hazards (PHA-8)

d) Confined Space Hazards (PHA-9)

e) Ozone Hazards (PHA-10)

f) Chemical and Hazardous Materials Hazards (PHA-11)

g) Accelerator/Beamline Hazards (PHA-12)

h) Ionizing Radiation Hazards (PHA-13)

i) Non-Ionizing Radiation Hazards (PHA-14)

j) Material Handling Hazards (PHA-15)

k) Experimental Hazards (PHA-16)

11.7.2 Codes and Standards

The following codes and standards will apply to design of facilities and systems related to the hazard areas identified above.

a) Building Code of New York State (2002)

b) NFPA 30 – Flammable and Combustible Liquids Code (2003)

c) NFPA 55 – Standard for the Storage, Use, and Handling of Compressed Gases and Cryogenic Fluids in Portable and Stationary Containers, Cylinders, and Tanks (2005)

d) OSHA 29 CFR 1910 – Standards for General Industry (2007)

e) ANSI Z136.1 – Safe Use of Lasers (2000)

f) ANSI Z9.5 – Standard for Laboratory Ventilation (2003)

g) CGA V-6 – Standard Cryogenic Liquid Transfer Connections (2000)

11.7.3 Hazardous Material Storage and Handling

a) Allowable Quantities

The maximum allowable quantities of hazardous chemicals and gases (unused chemicals and gases, materials in use, and waste) are dictated by the BCNY for any control area in a B-occupancy building. These are indicated in Tables 11.2 and 11.3.

Table 11.2 – Allowable Quantities of Chemicals

Maximum Allowable Quantities per Control Area		
Material	Allowed Storage(1)	Allowed Use (Open System)(2)
Flammable Class 1-A	120 gal	20 gal
Flammable Class I-B	240 gal	30 gal
Flammable Class I-C	360 gal	40 gal
Combined Flammables	480 gal	60 gal
Water Reactive Class 1	No limit	No limit
Water Reactive Class 2	200 lbs (3)	20 lbs (3)
Water Reactive Class 3	20 lbs	2 lbs
Oxidizer Class 1	800 gal	200 gal
Oxidizer Class 2	50 gal	10 gal
Oxidizer Class 3	4 gal	0.4 gal
Oxidizer Class 4	0.2 gal	0.02 gal
Unstable (Reactive) Class 1	No limit	No limit
Unstable (Reactive) Class 2	200 lbs	20 lbs
Unstable (Reactive) Class 3	20 lbs	2 lbs
Unstable (Reactive) Class 4	2 lbs	0.25 lbs
Toxic	500 lbs	125 lbs
Highly Toxic	40 lbs	3 gal
Corrosive	2,000 gal	200 gal

Notes:

1. Increased as allowed for automatically sprinklered spaces and use of approved storage cabinets.
2. Aggregate quantity of storage and in-use shall not exceed allowable quantity for storage.
3. Assumes sulfuric acid. Equivalent to 20 gallons in storage and 2 gallons in open use.

Table 11.3 – Allowable Quantities of Hazardous Gases

Maximum Allowable Quantities per Control Area		
Material	Allowed Storage(1)	Allowed Use (Closed System)(2)
Flammable	2,000 cf	2,000 cf
Pyrophoric	100 cf	20 cf
Highly Toxic	40 cf (3)	40 cf
Toxic	1,620 cf	1,620 cf
Oxidizing	3,000 cf	3,000 cf

Notes:

1. Increased as allowed for sprinklered spaces.
2. Aggregate quantity of storage and in-use shall not exceed allowable quantity for storage.
3. In approved gas cabinets only.

Definitions of “highly toxic” and “toxic” gases, as defined in the Toxic Gas Ordinance (TGO), are as follows:

"Highly Toxic" (Class I): material that has a median lethal concentration in air of 200 ppm or less by volume, when administered by continuous inhalation of one hour to albino rats weighing between 200 and 300 grams each

"Toxic" (Class II): material that has a median lethal concentration in air of more than 200 ppm but less than 3,000 ppm by volume, under the same conditions

For mixtures, the classification as "highly toxic" or "toxic" depends on the mole fraction of the toxic material in the mixture. For purposes of this analysis, it is assumed that all gases will be pure.

If the volume of any hazardous chemical or gas in storage or use exceeds the amount listed in Tables 11.2 or 11.3, the area in which it is stored and/or used in excess of these amounts must be H-occupancy.

b) Hazardous Material Storage Areas

The design criteria for hazardous chemical and gases storage areas are prescribed by the BCNY. There are criteria applicable to storage within control areas in B occupancies (within the maximum allowable quantities) and additional criteria applicable to rooms or buildings for storage of quantities exceeding the maximum allowable quantities per control area (H-occupancy storage rooms or buildings).

For storage of materials in less than or equal to the maximum allowable quantities in control areas, code requirements include the following.

i) Separation of the control area by 1-hour fire barrier from adjacent control areas with minimum 2-hour rated floor construction for levels above ground

ii) Where storage cabinets are used to increase maximum allowable quantities of materials, which is reflected in the amounts listed in Table 11.2, cabinets shall be constructed per code and a liquid-tight floor to minimum of 2 inches

iii) Where gas cabinets are used to increase maximum allowable quantities of materials, which is reflected in the amounts listed in Table 11.3, cabinets shall be constructed per code and ventilated to maintain negative pressure with respect to the surroundings. No more than 3 cylinders may be housed in a single cabinet.

iv) For exhausted enclosures where necessary per code or where provided to increase maximum allowable quantities, enclosures shall be ventilated at negative pressure relative to surrounding areas, and provided with automatic fire extinguishing system if flammables are stored therein.

For H-occupancy rooms or buildings intended for storage of hazardous materials in quantities exceeding the amounts allowed per control area, the following additional code criteria apply:

i) Liquid storage cabinets may not exceed 120 gallons of total storage capacity, with no more than 60 gallons of Class I or Class II liquids.

ii) A minimum aisle width of 4 feet is required between adjacent liquid storage racks and a minimum 8-foot main aisle must be maintained.

iii) Rooms for storage of liquids shall be ventilated and maintained negative to surrounding spaces.

iv) An automatic sprinkler system is required.

v) Spill control and secondary containment is required to contain a spill from the largest vessel plus 20 minutes of fire protection water flow over the minimum system design area or room area (whichever is smaller).

vi) Non-compatible materials shall be stored in separate, approved enclosures.

A central chemical storage building will be provided adjacent to the LOB-1 loading dock. This building will be designed as an H-occupancy building and will be subdivided by partial non-combustible partitions to separate oxidizers, water reactives, acids, bases, and toxics. If any highly toxic liquids are intended to be used in the NSLS-II facility, a separate room with 1-hour fire barrier would have to be constructed. This will be evaluated further during detailed design.

The chemical storage building will be constructed of non-combustible materials. No explosion venting panels will be provided. Spill containment per BCNY and FCNY requirements for H-occupancy spaces will be provided for these rooms, with leak detection systems capable of alarming to the facility control room.

A separate building will be provided for 90-day storage of waste chemicals at the same location outside LOB-1. Waste chemicals will be stored in individual containers in chemical storage cabinets in the room. The waste room will be divided by non-combustible partitions as required to provide segregation by chemical type (oxidizers, water reactives, acids, bases, and toxics). The room will be designed the same as the chemical storerooms.

Each chemical storeroom will be provided with an exhaust ventilation system with a minimum of 1 cfm per square foot of floor area. The system will be designed to operate continuously and exhaust to the outside without recirculation. Each room will be conditioned to a temperature range of 55 to 85 F.

Each chemical storeroom will be provided with an automatic sprinkler system. A combination safety shower/eye wash station will be provided in each storeroom.

Chemicals and wastes used in laboratories or in beamline hutches will be stored in approved enclosures, ventilated where required by code. It is anticipated that only small volumes of chemicals for immediate use will be stored outside the central chemical storage room.

Treatment chemicals for closed-loop water systems (e.g., scale and corrosion inhibitors and biocides for use in the cooling towers) will be stored in drums or portable totes, depending on the anticipated rate of consumption. These chemicals will be stored in suitable enclosures at the point of use.

Gas cylinder storage areas will be provided near the loading dock in each LOB. Space will be provided for storage of gas cylinders in delivery to the final points of use, and for empty cylinders awaiting collection. No central storage of gas cylinders will be provided for NSLS-II; these will be delivered on a "just-in-time" basis.

Cylinder racks will be segregated by gas type, e.g., flammables and oxidizers. Appropriate cylinder restraints will be provided. The need for cages or other form of security for new or empty cylinders will be further evaluated during the next phase of design.

c) Hazardous Material Distribution

The design criteria for fixed distribution of hazardous chemicals and gases are prescribed by the BCNY. These criteria include:

i) Piping system construction

ii) Automatic shutoff valves

iii) Pressure relief

iv) Backflow prevention

v) Leak detection

Other than chemicals for closed loop system conditioning and liquid nitrogen (addressed in a separate part of this section), no piped distribution of chemicals is anticipated.

Piping systems for treatment chemicals will be compatible with the chemical and will be provided with containment and leak detection.

For chemicals used for experimental purposes, liquid transfer of materials having an NFPA 704 hazard ranking of 3 or 4 will be by safety cans complying with UL 30. Liquid containers exceeding 5 gallons will be transported on a cart or truck. In addition, containers with materials that have a hazard ranking of 3 or 4 per NFPA 704 will be transported on a cart or truck, unless no more than two containers are hand carried in safety containers. The cart or truck will be capable of containing a spill from the largest single container being transported.

It is anticipated that inert gases will be piped directly from cylinders to the equipment using the gas, with the cylinders located near to the point of use and manually changed when required. If demand dictates that multiple cylinders can be in use for a particular purpose, or if automatic change-over from empty to full cylinders is required for uninterrupted operation, fixed gas manifolds with distribution piping to the point of use will be provided. This will be further evaluated during detailed design.

Wherever hazardous gases are used, these will be housed in approved gas cabinets and piped via contained piping systems from the cylinder manifold to the point of use. Hazardous gas piping systems will be provided with leak detection, excess flow protection, and automatic shutoff as required by applicable codes. This will also be further evaluated during detailed design.

d) Safety Showers/Eyewash Stations

OSHA (29 CFR 1910.151(c)) requires "where the eyes or body of any person may be exposed to injurious corrosive materials, suitable facilities for quick drenching or flushing of the eyes and body shall be provided within the work area for immediate emergency use." "Suitable facilities" is defined by OSHA as meeting current industry standards. ANSI Z358.1-2004 is the recognized industry standard. ANSI's definition of "hazardous material" includes caustics and additional substances and compounds that have the capability of producing adverse effects on the health and safety of humans. This standard requires the following:

i) Installation of eyewash and shower equipment in appropriate situations when employees are exposed to hazardous materials.

ii) Location of emergency showers and eyewashes within 10 seconds travel distance of and no greater than 55 feet from a hazard, located on same level as hazard, and with a travel path free of obstructions including doors.

iii) Shower valves of simple operation, turn off to on in one second or less, and providing hands-free operation once activated.

iv) Flushing fluids shall be tepid.

v) Showers can be either plumbed or self-contained.

vi) Flow alarms should be installed in shower supply piping to indicate when the unit is being used.

vii) Pressure and minimum flow requirements as provided in the standard.

For the NSLS-II facility, safety shower/eyewash stations will be located in the following areas:

i) Chemical and waste storage areas.

ii) Laboratories containing fume hoods.

iii) Experimental hutches where chemicals are used.

Water for safety showers and eyewashes will be either a central tepid water loop (potable water maintained at required temperature) or from local hot and cold potable water services with local mixing valve at each appliance. These alternates will be evaluated further during detailed design. Safety showers will not be fitted with flow switches. Safety showers in areas subject to freezing will be provided with suitable freeze protection.

Other Wastes

The types and volume of wastes that will be generated and transported by NSLS-II are not anticipated to differ markedly from those generated and transported by the existing NSLS. During a typical year of operation, NSLS-II will generate 3,000 to 5,000 pounds of wastes. The following are estimates of the types of wastes (in addition to waste chemicals):

i) Industrial Waste: oils and oily rags, cutting fluids, resin recharge rinse waters, and photographic wastes; oils and rinse water are the major components of industrial waste

ii) Radiological Waste: sources and other radioactive materials; eliminated by decay-in-storage when possible and disposed of as hazardous waste.

iii) Mixed Waste: eliminated by decay in-storage when possible and disposed of as hazardous waste

iv) Regulated Medical Waste: the Medical Department will dispose of syringes, needles, pipettes, vials, and razor blades

Storage areas meet appropriate code requirements will be provide at each LOB for non-chemical wastes. These areas will be B-occupancy.

11.7.4 Cryogenics Storage and Handling

Bulk storage of liquid nitrogen and liquid helium will be required at the new facility. These cryogenic fluids are used for cooling of magnets and other ring components, and for cooling of experimental apparatus.

Storage vessel and pressurized distribution piping system design and construction is governed by the ASME Boiler and Pressure Vessel Code (2007) and by ANSI/ASME B31.3 – Process Piping (2002). All piping systems and storage systems will be designed and installed to comply with applicable ASME and ANSI standards. Some specialized accelerator components that do not fall within code parameters will require engineering analysis to assure reliability.

The predominant hazard associated with distribution and use of cryogenic liquids is oxygen depletion in the event of a cryogen spill with subsequent flash to vapor (the expansion ratios for liquid nitrogen and liquid helium are 696 and 754 respectively, at 70° F). This hazard is present anywhere cryogenic liquids may be used in the facility, including the RF service building, tunnel, experimental hutches, and laboratories, and can result from a piping system failure, dewar leak, or similar occurrence. A lesser hazard is the potential for burns; this is typically mitigated by procedure and PPE.

The OSHA Respiratory Protection Standard 29 CFR 1910.134 defines an oxygen deficient atmosphere as an atmosphere containing less than 19.5% oxygen by volume. BNL has procedures in place to determine the Oxygen Deficiency Hazard (ODH) classification of any space where cryogenic liquids are used, and has established ODH control measures applicable to each hazard class. These control measures include ventilation (minimum one volume change per hour) for spaces with hazard class of 2 or greater, use of a personal monitor and availability of a self-rescue respirator for hazard class 1 or greater, and provisions for SCBA near the hazard area for spaces with hazard class of 4.

Determination of ODH hazard classes will be made during detailed design, when the scope of cryogen distribution and use is more firmly established. All spaces where cryogens may be used will be ventilated to at least one air volume change per hour. It is anticipated that the following additional control measures will be required:

a) Installation of local oxygen concentration monitors at locations where dewars may be used (e.g., in laboratories and experimental hutches). Monitors will be linked to local alarm lamps and sounders to provide warning alarms when the oxygen concentration falls to pre-determined levels. Warning lamps will be placed inside potential hazardous spaces and outside any entry to the space.

b) Dewar vessel filling stations will have interlocks to prevent flow of cryogenic fluid until the dewar is properly vented.

The need for emergency venting of enclosed spaces where cryogens are used will be evaluated during detailed design.

11.7.5 Material Handling

The new NSLS-II facility will be designed to accommodate delivery and movement of experimental equipment, facilities equipment components (e.g., pumps and motors) for service and maintenance, chemical containers, gas cylinders, dewars, water treatment ion exchange vessels for off-site regeneration, and other consumables for offices and laboratories from the loading docks to the points of use.

Accelerator and storage ring component installation will be addressed separately.

BNL has determined that there is no requirement for installation of a permanent bridge crane in the experimental hall. Provisions will be made for use of portable hoists. The requirement for permanent attachment points to structure will be determined during detailed design, along with method of personnel access to the attachment points for fixing hoists prior to use.

The need for permanent cranes or hoists in the service buildings will also be evaluated during detailed design.

Hoists will comply with applicable codes and standards, including the following:

a) ANSI/ASME B30.16-2003 - Standard for Overhead Hoists (Underhung)

b) ANSI/ASME B30.21-2005 - Standard for Manually Operated Lever Hoists

The following provisions will be made for material transport to and within the facility:

a) Roadway access to the inner ring with sufficient turning radii for an articulated tanker to make the initial helium delivery and for box van or flatbed truck for loading and unloading of equipment to the service buildings.

b) Roadway access with turning provisions for a box van or flatbed truck delivery to LOB loading docks for delivery of equipment, chemicals, gases, and other consumables. The main loading dock (at LOB-1) will be elevated and provided with dock levelers.

c) Roadway access suitable for an articulated tanker to make deliveries of liquid nitrogen to the storage tank between LOB-4 and LOB-5 and the future tank near LOB-2. The roadway layout will allow the tanker to unload without blocking other traffic to the LOB docks. Nitrogen storage tanks will be oriented away from personnel to reduce noise and fog exposure.

d) Bollards will be provided where necessary to protect equipment adjacent to roadways.

e) A nominal 10-foot wide circulation aisle will be maintained around the perimeter of the experimental hall to allow access to the beamlines from the LOB docks. The aisle will be suitable for forklift access for movement of heavy experimental equipment. Overhead services will be maintained at least 10 ft above the aisleway.

f) For beamlines which extend into the perimeter aisle and beyond, ramps will be provided with maximum slope to accommodate a forklift. Where the ramps are too steep for manual movement of liquid nitrogen dewars, automatic dewar fill stations will be provided at the LOBs on either side of the ramp(s).

g) An access aisle will be maintained at the perimeter of the mezzanine level.

11.7.6 Ionizing Radiation

Protection against ionizing radiation is addressed in DOE O 420.2B - Safety of Accelerator Facilities as well as in 10 CFR 830 Subpart B - Safety Basis Requirements of the Nuclear Safety Management Rule and 10 CFR 835 - Occupational Radiation Protection.

Shielding of the accelerator, storage ring, and beamline systems will be addressed elsewhere as part of the accelerator and storage ring systems design.

Beam interlocks, including exclusion zone search system interlocks, will also be addressed as part of the accelerator and storage ring systems design. These will be provided with the accelerator/storage ring installation.

11.7.7 Non-Ionizing Radiation

Regulatory requirements for control of exposure to non-ionizing radiation, including lasers and radiation in the radio frequency and microwave frequency regions, shall meet the Threshold Limit Values of the American Conference of Governmental Industrial Hygienists. The requirements for shielding will be addressed along with ionizing radiation shielding as part of the accelerator and storage ring component design and installation.

There is the potential for use of Class 1, 2, 3a, 3b, or 4 lasers as part of the beamline or laboratory experiments. BNL regulations regarding installation and user lasers will be applied to this project, including the requirement for failsafe laser interlocks for Class 4 lasers. This will be further evaluated during detailed design.

11.7.8 Process Exhaust

ANSI/AIHA Z9.5-2003 - Standard for Laboratory Ventilation and ANSI/AIHA Z9.2-2001 - Standard for Fundamentals Governing the Design and Operation of Local Exhaust Ventilation Systems are the governing standards for design of process exhaust systems for laboratory and experimental operations. These standards will define the criteria for process exhaust systems for NSLS-II. ANSI/AIHA Z9.2 is also referenced in OSHA 29 CFR 1910.94.

Laboratory fume hoods and corresponding process exhaust system(s) will be in accordance with Standard Z9.5. Evaluation of compatibility of exhaust streams to determine if multiple hoods can be manifolded will be made during detailed design. When chemical storage cabinets are integral with a fume hood, the chemical cabinet will be ventilated by the hood exhaust system.

An exhaust system will be required for experimental hutches that use hazardous chemicals or gases. The requirements for this system need further evaluation. Alternatives that will be evaluated during detailed design include:

a) Provision of a central exhaust system with capability to connect to any beamline hutch, installed as part of the conventional facility construction.

b) Provision for separate and dedicated exhaust systems for beamlines that require exhaust, installed with each beamline construction.

Chemical and gas storage cabinets in the central chemical store will be exhausted directly to atmosphere.

Process exhaust ductwork materials of construction will be selected to be compatible with the chemicals or gases being exhausted and compliant with applicable codes and standards with regard to smoke and flame spread rating.

11.7.9 Noise

29 CFR 1910.95 (OSHA) has established permissible noise exposures for the workplace. Additional requirements by the American Conference of Governmental Industrial Hygienists (ACGIH) are also established which are generally more stringent than OSHA. This project will limit noise to the ACGIH TLVs or even more strict requirements.

Appropriate equipment performance criteria and/or sound attenuation will be specified for plant equipment, particularly air handling units and pumps, to ensure that these noise levels are not exceeded in the service buildings and other plant spaces.

The required noise criteria for experimental areas, offices, and laboratories for the purpose of personnel comfort are significantly lower than the OSHA or ACGIH criteria. These criteria are listed in Table 3.5.

Design criteria to achieve these NC levels will be further developed during detailed design. These include ductwork sizing and routing restrictions as well as proper equipment selection and application of acoustic treatments.

11.7.10 Confined Spaces

Confined spaces will be identified and managed in accordance with the requirements in OSHA 29 CFR 1910.146 – Permit-Required Confined Spaces and with BNL's confined space access program. Wherever practical, the need for a confined space will be avoided during design.

11.8 Biological Safety

11.8.1

Requirements and criteria for biological safety systems are derived from the following codes and orders

a) 10 CFR 851 – Worker Safety and Health Program

11.8.2 BSL-2 Laboratories

It is anticipated that theNSLS-II program will require fit-out of at least one Biosafety Level 2 (BSL-2) laboratory for biological experimentation. Design of the laboratory and ventilation systems will be in accordance with ANSI/AIHA Z9.5-2003 - Standard for Laboratory Ventilation. Provisions will be made to restrict access to personnel with the appropriate training or other qualifications. There is no requirement for directional inward air flow in a BSL-2 laboratory, except as may be required for chemical odor control; although the BSL-2 laboratories at NSLS-II will be designed to be negative to the surrounding spaces.

A fume hood or Class II, Type A biological safety cabinet will be provided in each BSL-2 laboratory.

Additional requirements for BSL-2 laboratories will be established during detailed design.

11.9 Electrical Safety

11.9.1 Requirements

Requirements and criteria for electrical system design are derived from the following codes and orders:

a) Building Code of New York State (2002)

b) DOE O 420.2B –Safety of Accelerator Facilities

c) 10 CFR 851 – Worker Safety and Health Program

d) OSHA 29 CFR 1910.147 – Control of Hazardous Energy (Lockout/Tagout)

Design mitigation strategies are also identified in the PHA under PHA-6 (Electrical Hazards)

11.9.2 Codes and Standards

The following codes and standards will apply to design of facilities and systems related to the hazard areas identified above.

a) Building Code of New York State (2002)

b) NFPA 70 – National Electrical Code (2005)

c) NFPA 70E – Standard for Electrical Safety in the Workplace (2004)

d) NFPA 780 – Standard for Installation of Lightning Protection Systems (2004)

11.9.3 Design Requirements

Specific requirements for implementation of applicable electrical codes and standards will be defined in the next phase of design. These requirements may include, but not be limited to, the following.

a) Specification of NRTL-approved devices.

b) Review of cable segregation, cable tray loadings, and cable stirrups.

c) Completion of an arc flash analysis for all electrical panels and disconnects.

d) Location of disconnects and provisions for lockout/tagout.

e) Provisions for adequate power distribution for beamline and experimental equipment, including allowances for future beamline installation.

f) Maintenance of proper clearances around distribution panels and other electrical equipment.

11.10 Other Environment, Safety And Health Issues

11.10.1 Experimental Operations

Most of the experimental hazards identified in the PHA are addressed in other sections of this chapter (e.g., chemical handling, ODH hazards resulting from use of cryogenic liquids).

PHA-10 describes the hazards associated with the generation of ozone when the unattenuated synchrotron beam passes through air. This hazard is most likely to occur at the experimental end stations. Several mitigation strategies are identified in the PHA, most of which are related to end station set-up. The need for conventional facilities such as extract or local air filtration will be further evaluated during detailed design.

11.10.2 Emissions to Air and Releases to Groundwater

PHA-3 describes the anticipated environmental hazards resulting in operation from the NSLS-II facility. BNL has also prepared an Environmental Assessment (EA) for the facility which describes anticipated environmental impacts in more detail.

Potential environmental hazards from NSLS-II include the potential for releasing, in amounts beyond regulatory limits, oils, solvents, chemicals, and radioactive material to the soil, groundwater, air, or sanitary system as a result of the failure of equipment, impact from a natural phenomenon, fire, or a violation of established procedure.

Accelerator cooling water will be a closed-loop system with no anticipated discharges other than the potential rinsing of ion exchangers before they are brought on-line. While some accelerator components become locally activated as a result of operations, the levels are expected to be well below BNL's Accelerator Safety Subject Area guidelines for soil activation.. NSLS-II would not generate tritiated water above the BNL defined Action Level. Periodic sampling of the cooling water systems will assure that tritium levels remain below the Action Level.

Experiments using radioisotopes will be controlled by specific facility procedures, rendering remote the likelihood of these materials entering the sanitary or groundwater systems.

Roof and parking lot drains will empty into groundwater recharge basin 005 that lies southeast of the NSLS-II site. Cooling tower blowdown will be discharged to a separate stormwater collection basin. All other water discharges will be disposed of through the sanitary waste stream; there are no expected requirements to monitor this outflow's quantity or chemistry.

Exhaust emissions from laboratory fume hoods and experimental hutches are associated with research and development and, therefore, would be exempt from Federal and state permitting requirements. Fume hood exhaust systems will be designed to permit the installation of HEPA filters in the exhaust stream should experimental conditions warrant.

11.10.3 Equipment Protection

a) Leak detection will be provided where the potential for liquid leaks exist in areas that are not normally occupied (e.g., the tunnel), to provide remote indication of a potential piping or equipment system failure. An unobserved leak could result in equipment damage, injury to personnel, or both.

b) Access control requirements for protection of sensitive and/or hazardous spaces will be evaluated in the next phase of design.